United States Environmental Protection Agency **Office of Research and Development**

National Exposure Research Laboratory
Research Abstract

Government Performance Results Act (GPRA) Goal 4
Annual Performance Measure 250

Significant Research Findings:

Estimating and Projecting Impervious Cover in the Southeastern United States

Scientific Problem and Policy Issues

The pressure on water resources due to urbanization is rapidly increasing as the U.S. population grows. Along with increased development comes increased impervious surfaces--areas such as roads, parking lots, driveways, and buildings–which prevent infiltration of water into the underlying soil. The most difficult to control and correct impact of urbanization on water courses is the extensive hydrologic alteration of watersheds , i.e., excessive (as well as polluted) runoff from these increased impervious surfaces. Development practices that reduce effective impervious area and include other strategies to protect water quality are more effective and less costly than remedial restoration efforts. Impervious area estimates and projections are a potentially effective tool for highlighting areas that are at-risk for aquatic resources degradation or where stream system integrity is likely to decline in the near future if effective planning and management programs are not implemented. These estimates and projections can guide the selection of monitoring locations by state and regional EPA officials, focus educational efforts in at-risk areas, and aid wide-area planning. However, the use of impervious cover as an effective screening tool for identifying at-risk streams requires an easy and reasonably accurate method for estimating it over a large area. In addition, the ability to identify at-risk areas also requires the development of approaches for estimating impervious cover that link projections of imperviousness to socioeconomic projections.

Research Approach

The overall goal of this study is the development and application of a simple, reliable method for estimating and projecting impervious cover in small watersheds for all the states in EPA's Region 4. The first step in meeting this objective was the development of a test data set of impervious cover for a range of development intensity. Test data were collected from aerial photographs in two separate locations including 56 watersheds in Frederick County, Maryland and 13 watersheds in the Atlanta, Georgia area. Following the evaluation of single data type approaches for estimation and projection of wide area impervious cover, the Region 4 estimates were based on the use of multiple data sources –block level census data, categorized land use/land cover data and road networks. The different data types were used to represent components of imperviousness most appropriate to the specific data source. Population density was used as an indicator of impervious cover generated by residential development. Categorized satellite imagery was used to evaluate the contribution of commercial and industrial areas–areas that are clearly identified from satellite imagery. Road network data was used to estimate impervious cover contributed by major highways that wasn't related to local residential development. This approach estimated impervious cover on average within approximately 1% total impervious area in the test watersheds without any parameter fitting to the test data set.

Results and Impact

Complete identification and eventual prevention of urban water quality problems pose significant monitoring and water quality management challenges. The multiple data source wide area impervious estimation and projection technique can assist in meeting these challenges by providing: 1) cheap estimates of impervious cover at the watershed and sub-watershed scales; 2) a region-wide approach to screening for waters likely impaired or threatened by urban storm water; and 3) projections of change in imperviousness over time. The current impervious area estimates identify specific watersheds where existing adverse impacts due to impervious surfaces are likely. Some urban streams in these watersheds are listed as impaired through Section 303(d) of the Clean Water Act and are subject to TMDL development. However, many potentially degraded waters are not yet listed, primarily due to a lack of systematic monitoring approaches to identify urban water quality problems. Using the results presented in this study, potentially degraded streams that are not already listed under the 303(d) impaired waters listing process for sediment and biological integrity impairment can be prioritized for monitoring to ascertain if they are in fact impaired. The future impervious area projections of this study highlight the high growth areas of the Southeast, and the specific watersheds where this growth will be most likely to occur – areas where effective storm water management and prevention of urban storm water impacts are likely to be most cost effective.

Research Collaboration and Research Products

This research was performed in collaboration with USEPA Region 4 with the participation of Jim Harrison through the Regional Research Partnership Program. Stream benthic data were kindly provided by Trish MacPherson of the North Carolina Division of Water Quality (NCDWQ), along with point watersheds delineated for those sites graciously shared by Dr. Halil Cakir and Dr. James Gilliam of North Carolina State University. A report describing this research in detail can be found at http://www.epa.gov/athens/publications/downloadable.html. Additional publications from this study include:

Bird, S.L., Exum, L.R. and Alberty, S. 2000. "Generating high quality impervious cover data." *Quality Assurance. 8:91-103.*

Bird, S., Harrison, J., Exum, L., Alberty, S., and Perkins, C. 2002. "Screening to Identify and Prevent Urban Storm Water Problems: Estimating Impervious Area Accurately and Inexpensively." Proceedings of the National Water Quality Monitoring Council Conference. May 19-23, 2002. Madison, WI.

Future Research

A good assessment of impervious cover projections can only come as a retrospective analysis similar to what has been done at multiple scales for population projections. A post hoc assessment of projections of impervious cover is important follow on to this research. In addition, proposed future research includes assessment of the percent total impervious area vs percent effective impervious area along with comparison of the ratio of rooftops vs. roads and commercial vs. residential changes over time. Methods to improve determination of these subcategories of imperviousness will provide better indicators of aquatic health.

Contacts for Additional Information

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